

**A REPORT TO CONGRESS**

**Surface Transportation  
Research and Development Plan**

***Fourth Edition***

**A Report of the Secretary of Transportation  
Pursuant to the  
Intermodal Surface Transportation Efficiency Act of 1991  
Section 6009(b), P.L. 102-240**

# **A Report to Congress**

## **Surface Transportation Research and Development Plan**

### ***Fourth Edition***

**Prepared for:**

**U.S. Department of Transportation  
Washington, D.C.**

***<http://www.dot.gov>***

**Prepared by:**

**U.S. Department of Transportation  
Research and Special Programs Administration  
Volpe National Transportation Systems Center  
Transportation Strategic Planning and Analysis Office  
Cambridge, Massachusetts**

***<http://www.volpe.dot.gov>***

DOT-T-97-21

# Surface Transportation Research and Development Plan

## TABLE OF CONTENTS

	Page Number
■ <b>Executive Summary</b> . . . . .	i
■ <b>Section I: Introduction</b> . . . . .	1
■ <b>Section II: Strategic Plan for Surface Transportation Research and Development</b> . . . . .	11
Chapter 1: Transportation in 2020 . . . . .	13
Chapter 2: Strategic Goals and the Role of Research . . . . .	21
Chapter 3: Priority Strategic Partnerships . . . . .	33
Chapter 4: Development of the Enabling Technology Base . . . . .	55
Chapter 5: Education and Training . . . . .	61
Chapter 6: Measuring Success and Establishing Future Directions . . . . .	65
■ <b>Section III: Near-Term Plan for Surface Transportation Research and Development</b> . . . . .	77
Chapter 1: Near-Term Surface Transportation Research: Introduction . . . . .	79
Chapter 2: Physical Infrastructure . . . . .	85
Chapter 3: Information Infrastructure . . . . .	115
Chapter 4: Next-Generation Vehicles and Fuels . . . . .	151
Chapter 5: Human-Centered Transportation Systems . . . . .	163
Chapter 6: Intermodal Systems Assessment, Design, Planning, Management, and Operations . . . . .	171
Chapter 7: DOT Investment in University Research, Education, and Cooperative Initiatives . . . . .	191
Chapter 8: DOT R&D Facilities and Administrative Support for R&D . . . . .	203
■ <b>Section IV: Contracting Procedures</b> . . . . .	207
■ <b>Appendix A: Index of Near-Term R&amp;D Funding and Staffing Plans</b> . . . . .	A-1
■ <b>Appendix B: Preliminary Performance Measures for DOT R&amp;D Programs</b> . . . . .	B-1
■ <b>Appendix C: List of Acronyms</b> . . . . .	C-1

## **EXECUTIVE SUMMARY**

### **Surface Transportation Research and Development Plan**

#### **Fourth Edition**

##### ***Introduction***

Section 6009(b) of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) requires that the U.S. Department of Transportation (DOT) develop an integrated National Surface Transportation Research and Development (R&D) Plan that focuses on the research needed over the next decade. The congressionally mandated objectives of the plan are as follows:

- (1) To develop a range of technologies needed to produce convenient, safe, and affordable modes of surface transportation to be available for public use beginning in the mid-1990's; and,
- (2) To maintain a long-term advanced R&D program in order to provide for the next generation of surface transportation systems.

These objectives lead directly to the structure of the plan, which focuses on two time periods:

- (1) A Near-Term section (Section III, Chapters 1-8), which focuses on ongoing or projected programs and their conduct over the next three years; and,
- (2) A Long-Term section (Section II, Chapters 1-6), which focuses on the directions of DOT's transportation R&D over the next ten years and beyond.

In addition, the Government Performance and Results Act of 1993 (GPRA) has emphasized the need for strategic planning and mechanisms for performance assessment in Federal executive agency programs. This edition of the plan, which is the fourth to be issued, therefore has begun to examine ways to assess R&D program content and impacts, and for the first time discusses alternative approaches to doing this.

##### ***Long-Term Research Directions***

Transportation R&D is a major lever in helping the nation accomplish its goals in transportation and other sectors of our society. The DOT R&D program must, therefore, support the directions established in the DOT Strategic Plan. The third edition of the plan emphasized the development of the link between R&D programs and accomplishment of Departmental goals. It evolved a series of 16 research thrusts, cutting across all surface

modes. This set of thrusts, however, only began to consider programs outside of DOT's, support of non-transportation objectives, and set priorities among program choices.

There were three major drivers over the last year which have started to move the Department and, hence, the Plan to address longer-time horizons and national-scale policy issues.

- In September 1996, the General Accounting Office (GAO) completed a detailed assessment of DOT's Surface Transportation R&D Program, summarized in the report Surface Transportation: Research Funding, Federal Role and Emerging Issues. The study concluded that DOT's research focused on improving individual modes of transportation, rather than on creating an integrated framework for needed research. It found investment in surface transportation research was inadequate to build knowledge in the areas of system assessment, policy research and intermodal research, as well as in basic, long-term, high-risk research. A more strategic perspective was needed in DOT's R&D program development.
- The GPRA requires the development and use of performance measures for agency management, and may ultimately lead to their use in allocating budgets. It also requires Government-wide implementation of strategic planning, annual planning, and program goal-setting with "objective, quantifiable, and measurable" indicators of performance. DOT is implementing the mandates of GPRA throughout all its programs, not just in the R&D area.
- The National Science and Technology Council's (NSTC's) Interagency Coordinating Committee on Transportation R&D prepared the first-ever government-wide Transportation Science and Technology Strategy. As the highest-level technical coordinating body in the Federal government, the NSTC has played a key role in helping to prioritize the Government's transportation R&D investments. The NSTC Strategy provides a framework for guiding Federal transportation R&D toward meeting national transportation system goals, not simply Departmental or surface transportation system ones. The Strategy is based on the results of numerous outreach events, environmental scans, and an analysis of the transportation system's current and future strengths, weaknesses, opportunities, and threats.

DOT has, therefore, refined its approach to R&D program planning. The intent of this year's plan is to use the GAO findings and recommendations, the GPRA implementation activities, and the NSTC's strategy formulation efforts to have national goals and performance measures guide Federal transportation R&D investments. Then, over time, it will be able to measure the impacts of those R&D investments on the performance of the nation's transportation system.

The DOT R&D plan has therefore adopted the NSTC Strategy's conceptualization of a coordinated Federal science and technology program, and how its elements must relate. The Strategy establishes a four-tiered approach:

1. Strategic Planning and Assessment activities establish how specific technologies can support achievement of national priorities.
2. Strategic Partnership Initiatives link governments at all levels, industry, and academia to bring the most needed, highest payoff technologies into widespread use.
3. Enabling Research develops knowledge and technological improvements which can then make possible solutions to transportation problems, or provide new transportation options.
4. Transportation Education and Training provides the cadre of competent transportation professionals to develop and apply new options and technologies.

Consistent with the NSTC's guidance, the DOT Surface Transportation R&D Plan then places its emphasis on the following partnership initiatives in surface transportation:

#### *Transportation Information Infrastructure*

- Smart Vehicles and Operators
- National Intelligent Transportation Infrastructure
- Enhanced Transportation Weather Services
- Enhanced Goods and Freight Movement at Domestic and International Gateways
- Accessibility for Aging and Transportation-Disadvantaged Populations
- Local Environmental Assessment Systems

#### *Next-Generation Vehicles*

- Next-Generation Motor Vehicles and Ships

#### *Transportation Physical Infrastructure*

- Total Terminal Security
- Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure
- Environmental Sustainability of Transportation Systems

The DOT Surface R&D plan also highlights six enabling research areas that support long-term national transportation goals. These are typically project areas whose benefits are too widely spread for any one company to recover its investment, whose cost or risk is too great for one

company to bear, and whose benefits are too far in the future to meet private investment criteria:

### *Enabling Research Topics*

- Human Performance and Behavior
- Advanced Materials
- Computer, Information, and Communication Systems
- Energy and Environment
- Sensing and Measurement
- Tools for Transportation Modeling, Design and Construction

These top-priority partnership initiatives and enabling research topics are remarkably consistent with the research thrusts identified in the Third Surface Transportation R&D Plan.

Table III-1-1 presents the linkages between the partnership initiatives and those thrusts.

In addition, the document examines how to measure the success of, and establish future directions for, these longer-term research projects. It differentiates between "outcome" measures, which characterize the impacts of R&D once implemented, versus output measures, which document the products generated by the research efforts themselves. The indicators currently used by DOT in conducting assessments of the success of its research are collected and discussed.

### ***Shorter-Term Research Directions***

DOT's ongoing research activities make important contributions in the long-term areas highlighted above. DOT has active research proceeding on a variety of topics:

#### *Physical Infrastructure*

R&D includes development of stronger more durable, less expensive, easier-to-maintain materials; nondestructive testing and infrastructure monitoring techniques; improved design and construction practices; recycling and re-use of byproducts and waste products; and designs and construction approaches for more effective intermodal facilities.

#### *Information Infrastructure*

R&D includes network-based approaches to traffic control; collision warning and avoidance systems; technology for automated vehicle control and information systems; positive train control; developing the capacity to deal with hazardous materials incidents; antilock braking systems; vehicle safety information systems; information systems for drivers and other travelers; and advanced vehicle fleet management techniques.

### *Next Generation Vehicles and Fuels*

R&D includes identifying near-term options for improving motor carrier safety; improving vehicle safety for children riding in passenger vehicles; evaluating the characteristics of vehicle crashes to determine hazards and safety needs; developing countermeasures for improved frontal crash protection; developing improved crash test dummies; developing nonelectric high-speed passenger locomotives; examining the safety of tilting high-speed rail cars; continuing the development of advanced transit bus technology; and developing and applying fuel cells in transportation vehicles.

### *Human-Centered Transportation Systems*

R&D includes continuing work to identify and reduce the impacts of driver fatigue on transportation safety; developing improved displays for vehicle operators and controllers; developing a better understanding of the degrees of impairment associated with specific blood alcohol levels; developing more effective applications of advanced navigation technologies to improve safety; improving the placement and level of integration of vehicle gauges for transportation drivers; and updating drug and alcohol program implementation guidelines.

### *Intermodal Systems Assessment, Design, Planning, Management, and Operations*

R&D in this area includes analysis of the sustainability of transportation systems; exploring the capability of supercomputer-based transportation planning models; continuing development of the National Advanced Driving Simulator (NADS); identification of injury mechanisms and outcomes in vehicle crashes; development of services to meet the special mobility needs of children, the elderly, and the handicapped; conducting "Bridges to Work" demonstrations to help unemployed inner-city dwellers rejoin the workforce; and examination of innovative financing techniques for transportation.

The document also explores the potential of DOT's cooperative programs with various sectors of the transportation industry through university based research and training programs; cooperative research programs with state and local governments; and fellowships to help continue the education of promising transportation professionals. Closely related, improvements in procurement and research support mechanisms also hold significant promise for improving the quality and responsiveness of America's transportation R&D to its national needs.